Imaging the source region of the 2003 San Simeon earthquake within the weak Franciscan Subduction Complex, Central California

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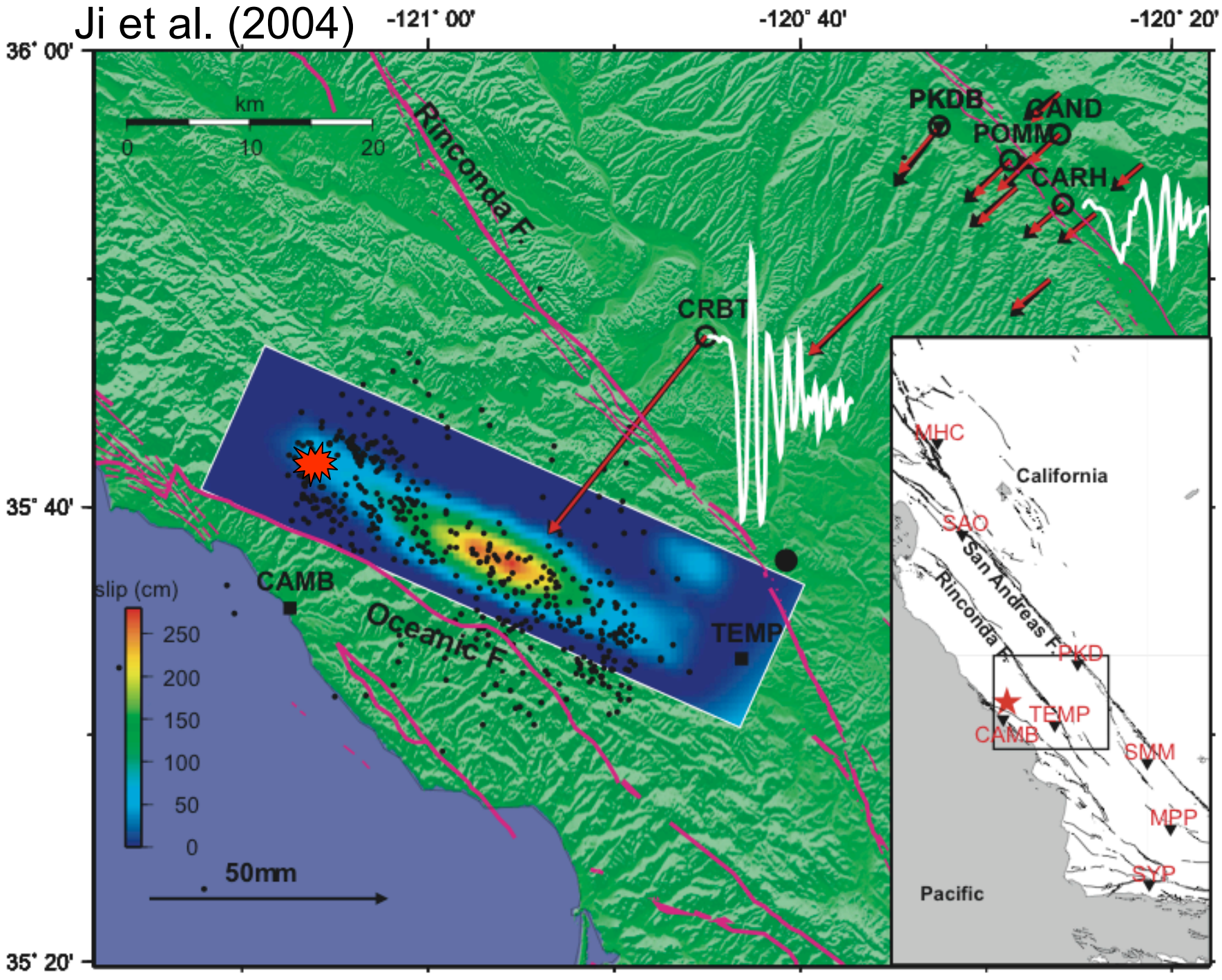
Asilomar & Parkfield, California

Tasks

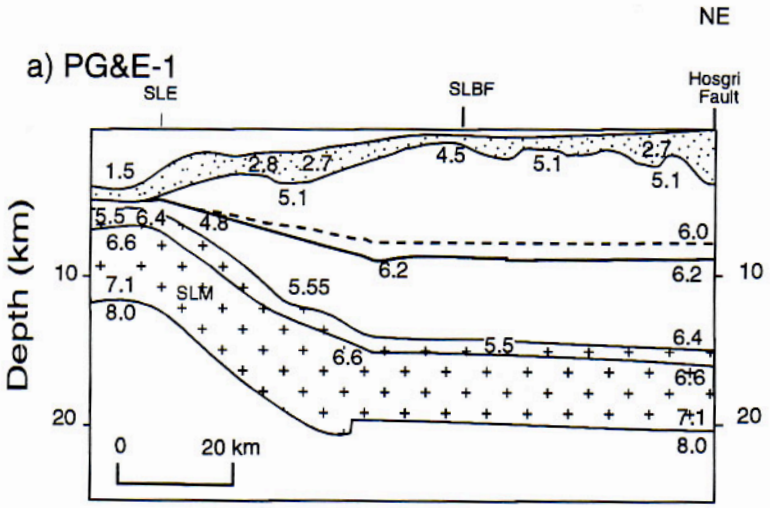
- Determine 3-D *Vp* and *Vp*/*Vs* models
- Refine hypocenters
- Compare to finite source model of Chen Ji

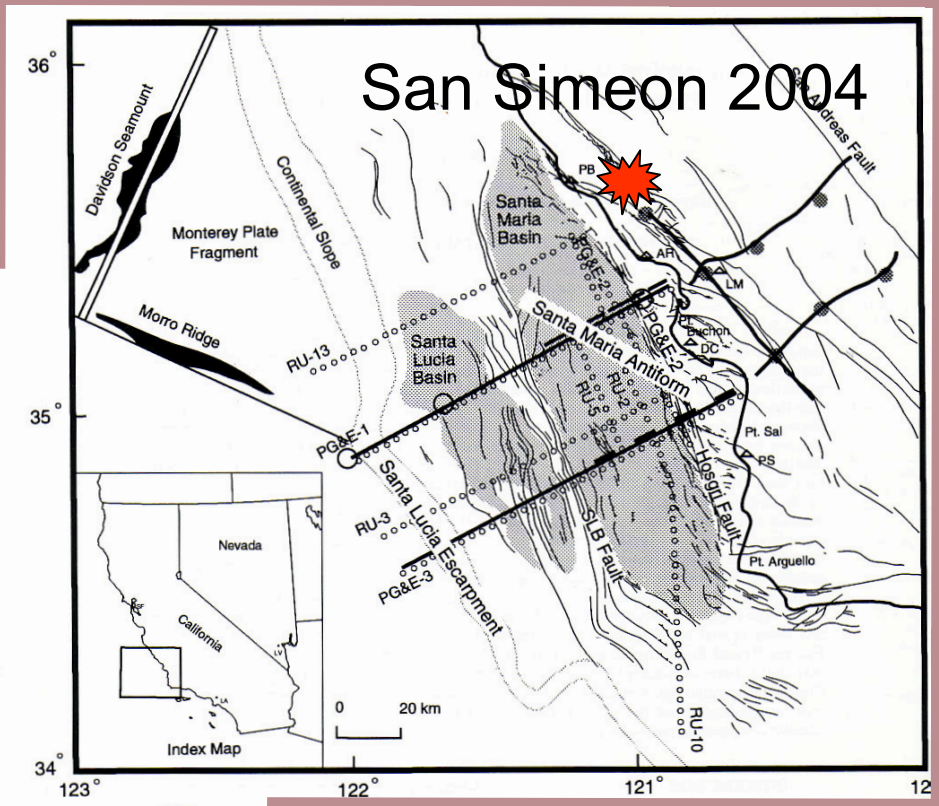
Motivation

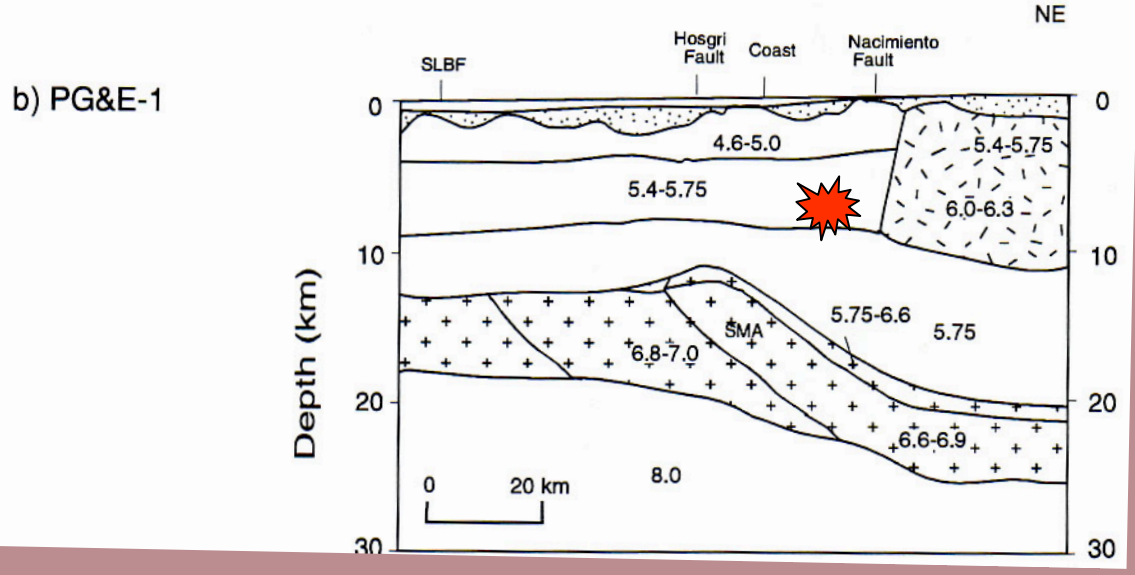
- Relation to local fault structures
- Anomalous structure around the rupture
- Comparison with LA thrust earthquakes

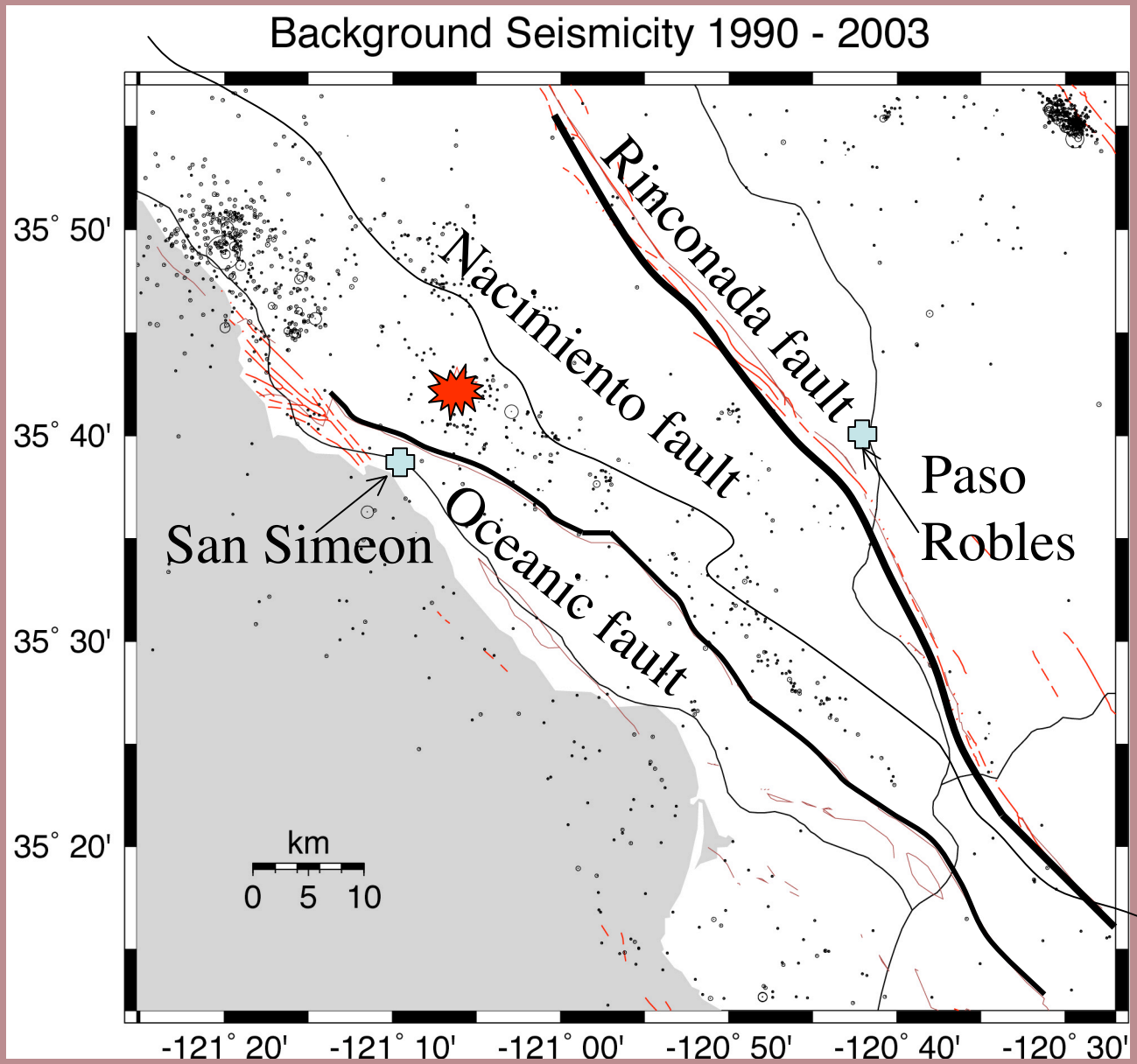

Ji et al. (2004)
-121° 00'
-120° 40'
-120° 20'
36° 00'
35° 40'
35° 20'
km
0
10
20
Rinconda F.
PKDB
GAND
POMM
CARH
CRBT
MHC
California
SAO
San Andreas F.
Rinconda F.
PKD
TEMP
CAMB
SMM
MPP
SYP
Pacific
slip (cm)
250
200
150
100
50
0
50mm
CAMB
Oceanic F.
TEMP

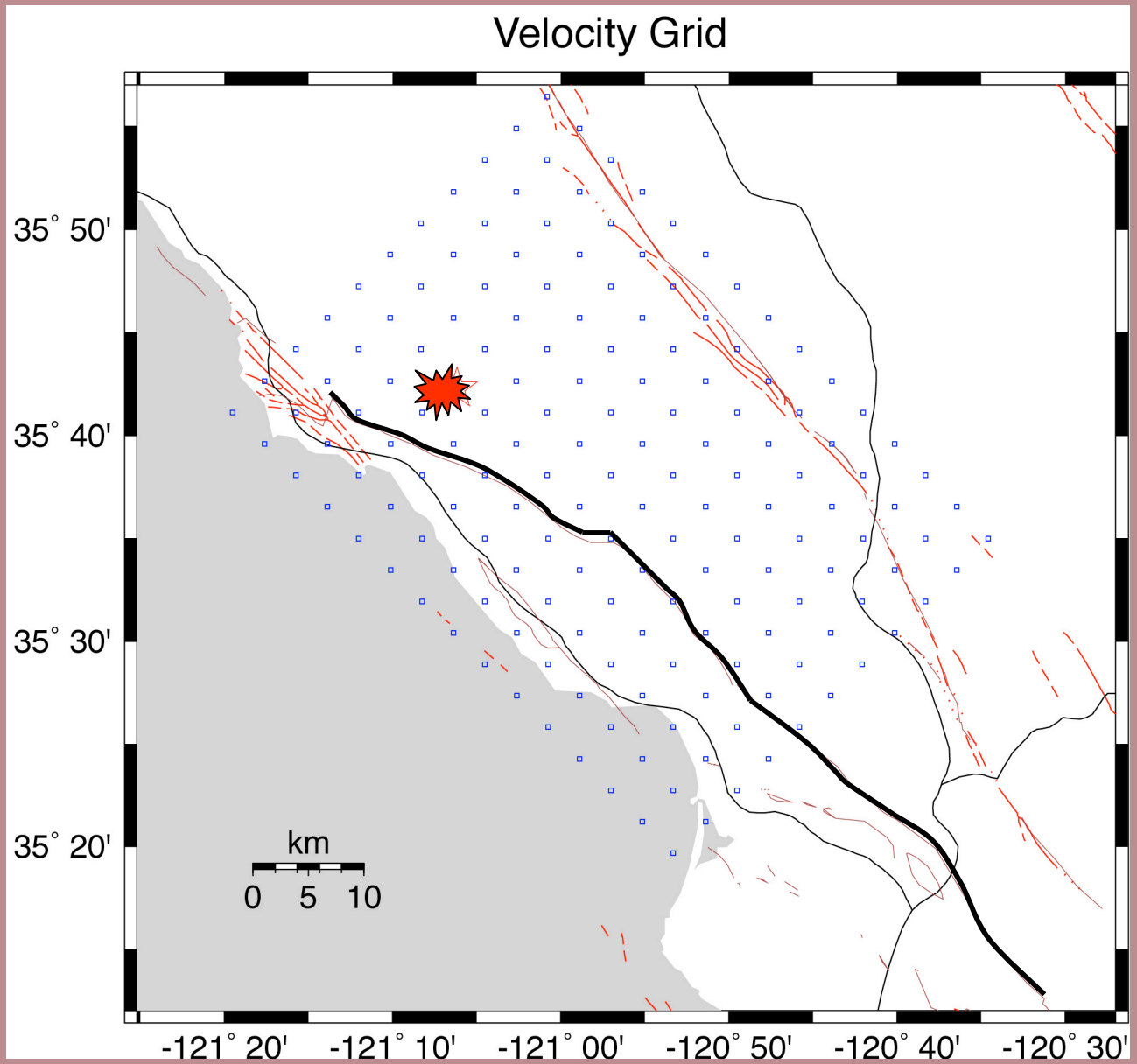
Miller at al., (1992)

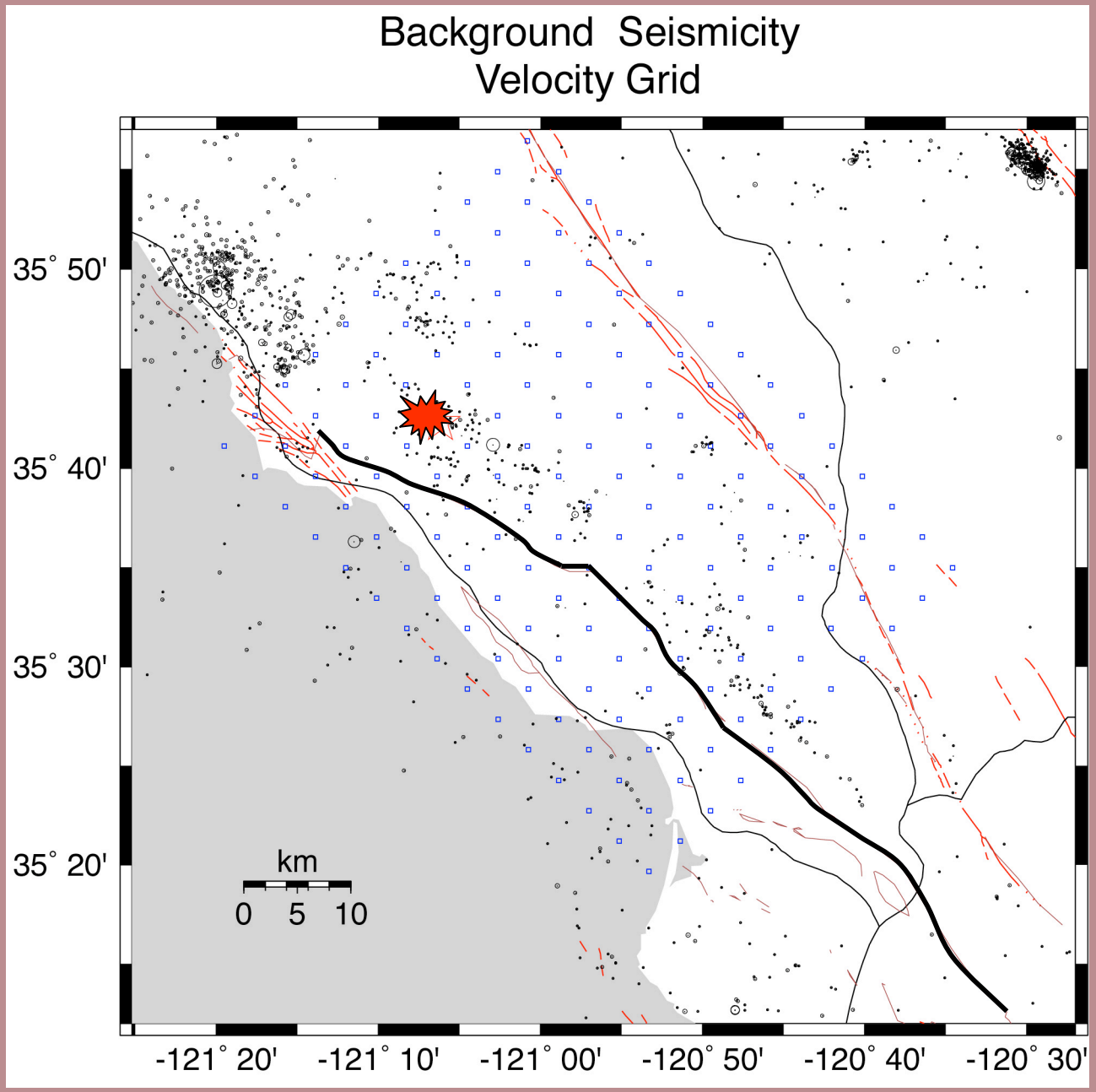


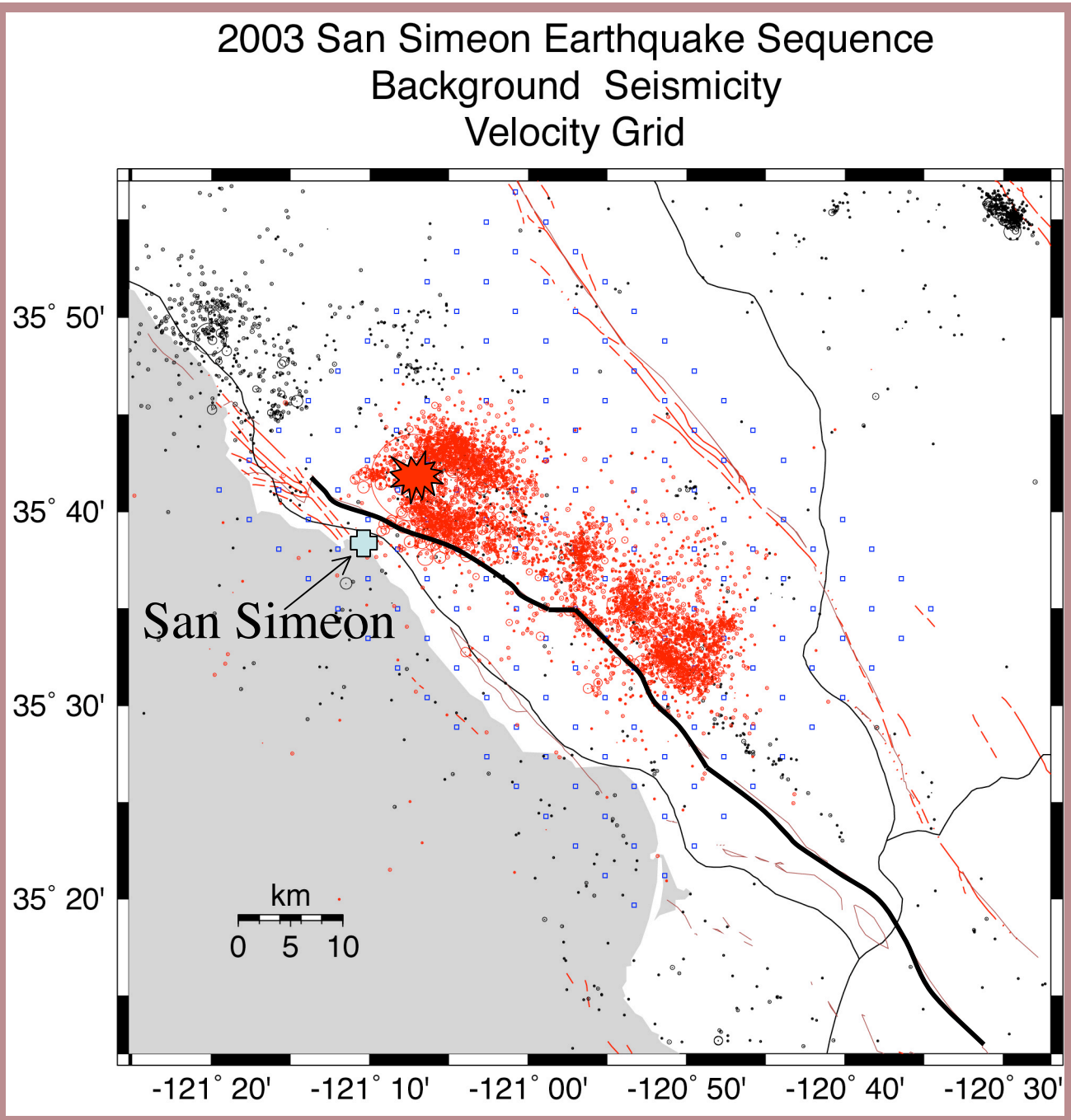





Background Seismicity 1990 - 2003
35° 50'
35° 40'
35° 30'
35° 20'
-121° 20'
-121° 10'
-121° 00'
-120° 50'
-120° 40'
-120° 30'
Rinconada fault
Nacimiento fault
Oceanic fault
San Simeon
Paso
Robles
km
0 5 10


Velocity Grid
35° 50'
35° 40'
35° 30'
35° 20'
km
0 5 10
-121° 20'
-121° 10'
-121° 00'
-120° 50'
-120° 40'
-120° 30'


Background Seismicity
Velocity Grid
35° 50'
35° 40'
35° 30'
35° 20'
km
0 5 10
-121° 20'
-121° 10'
-121° 00'
-120° 50'
-120° 40'
-120° 30'


2003 San Simeon Earthquake Sequence
Background Seismicity
Velocity Grid
35° 50'
35° 40'
35° 30'
35° 20'
San Simeon
km
0 5 10
-121° 20'
-121° 10'
-121° 00'
-120° 50'
-120° 40'
-120° 30'

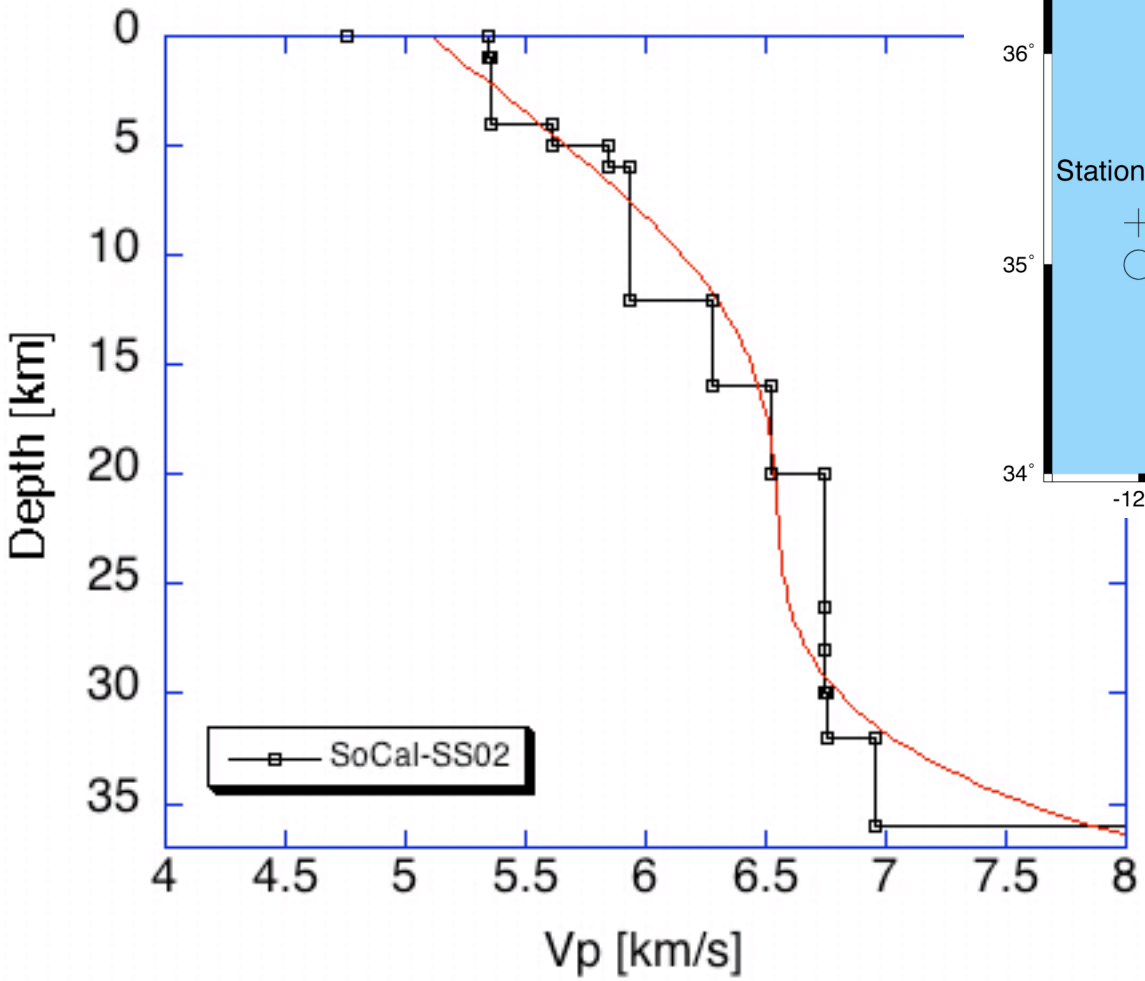
Methods and Approach

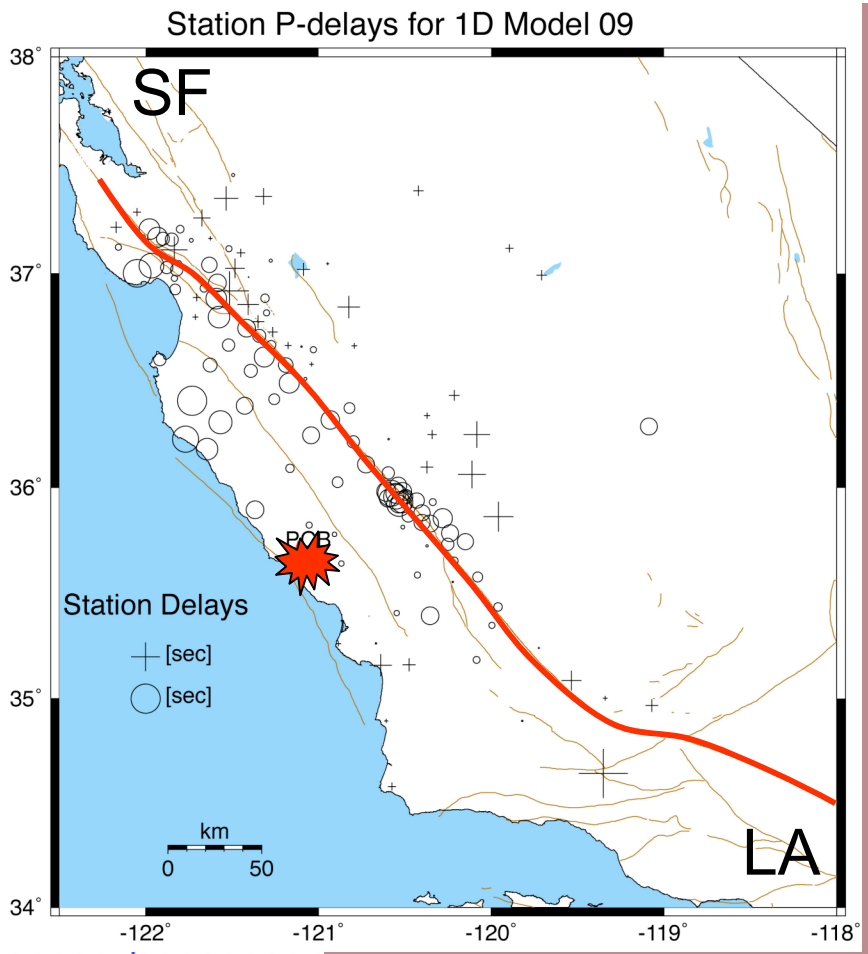
1) **Minimum 1-D model**
   VELEST from Kissling et al. (1993)

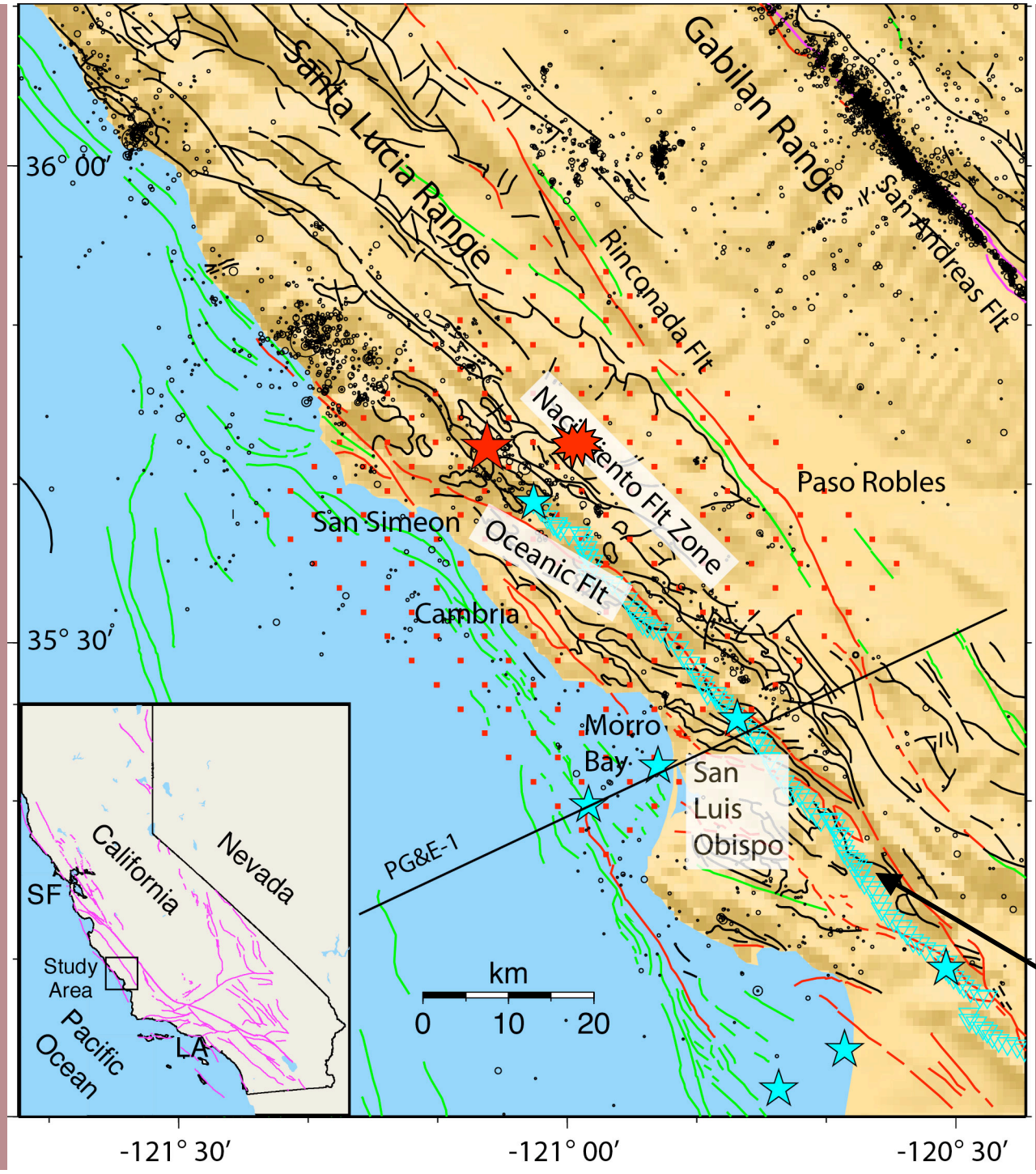
2) **3-D Vp and Vp/Vs Models**
   Simulps from Thurber & Eberhart-Phillips (1993)

3) **Relocations of hypocenters**
   HypoDD - Waldhauser & Ellsworth (2001)

Refined 1D So. Calif. Model







Refraction Experiment

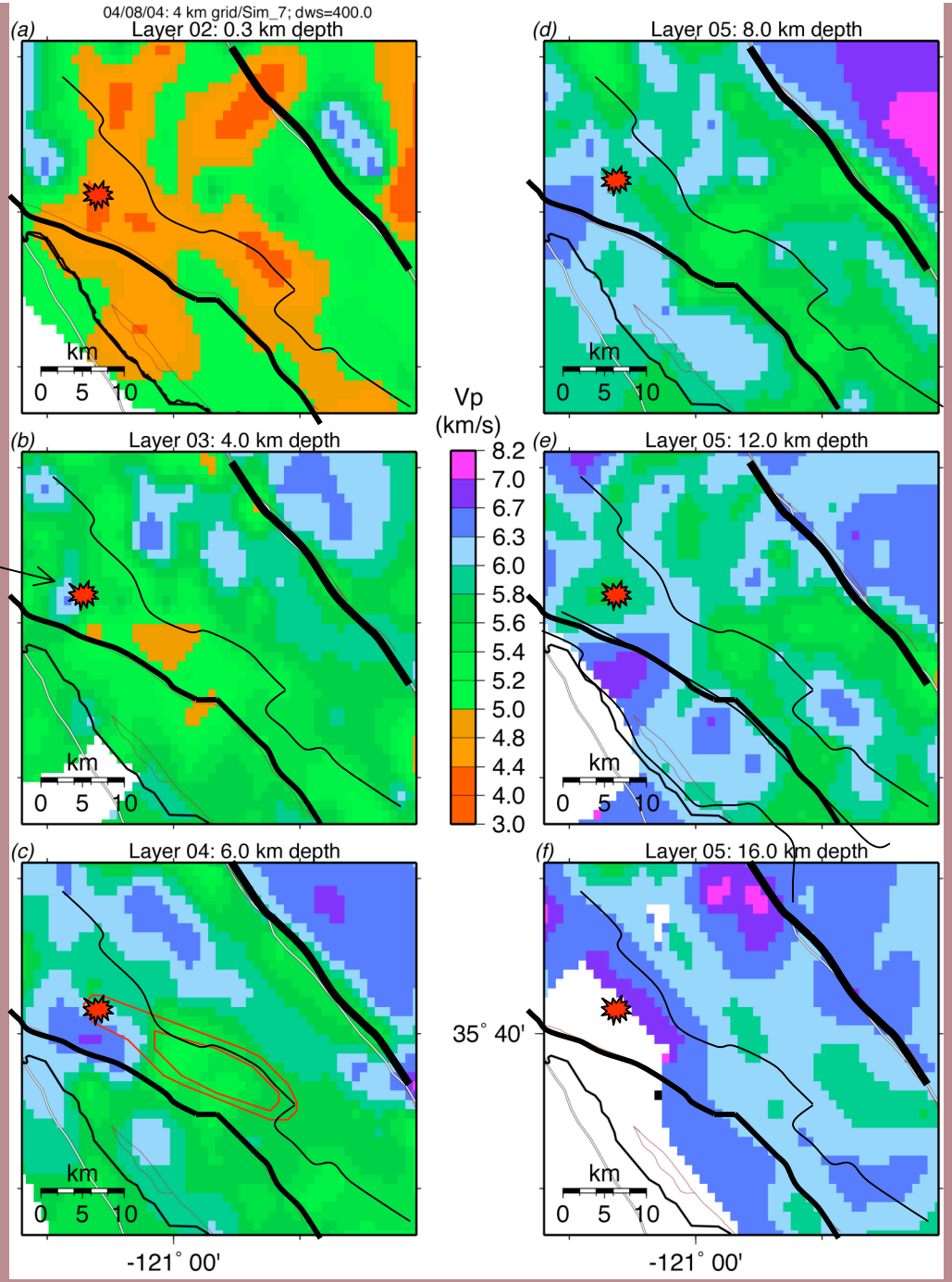
0.3 km

Vp

4.0 km

Epicenter

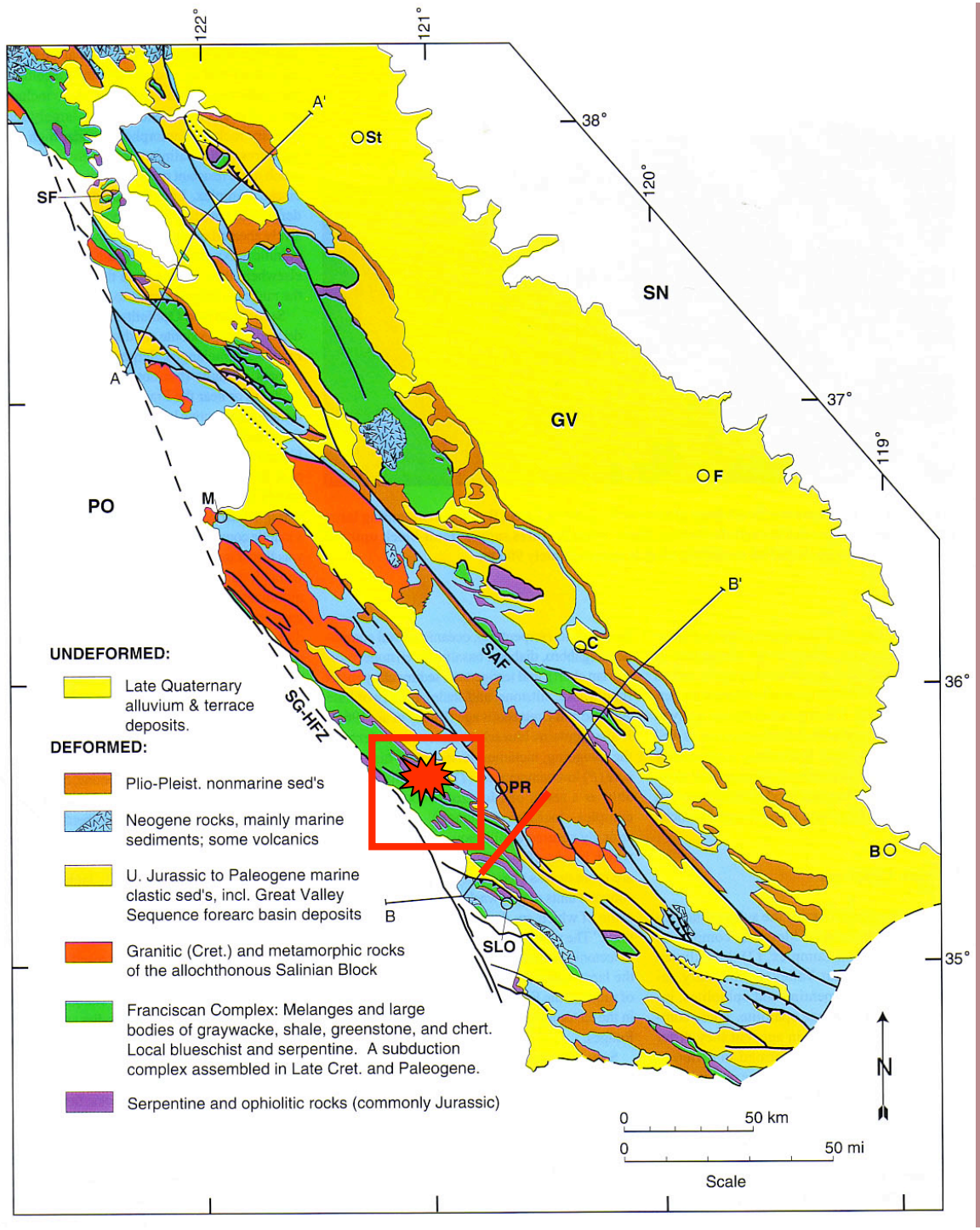
6.0 km

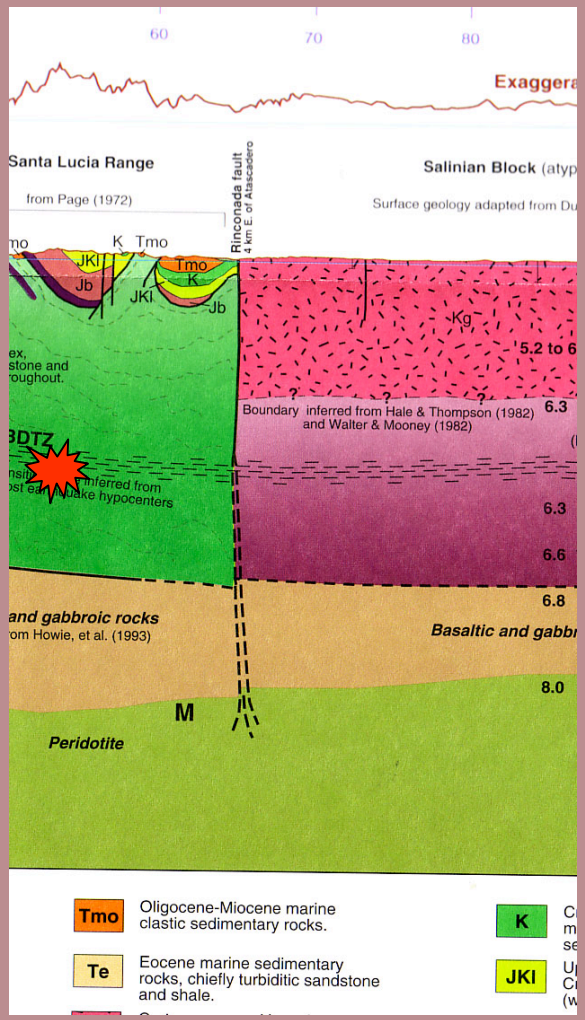


8.0 km

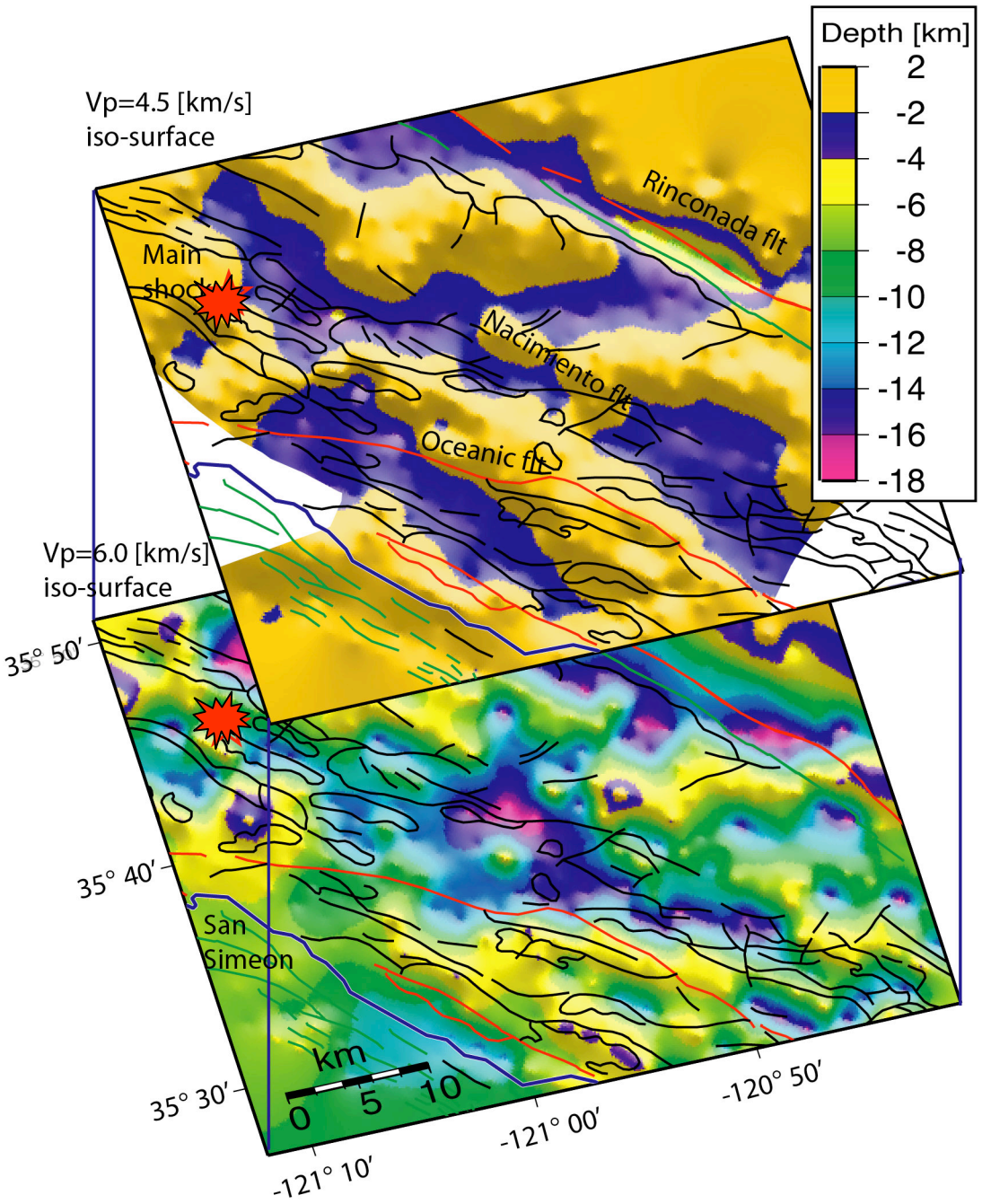
12.0 km

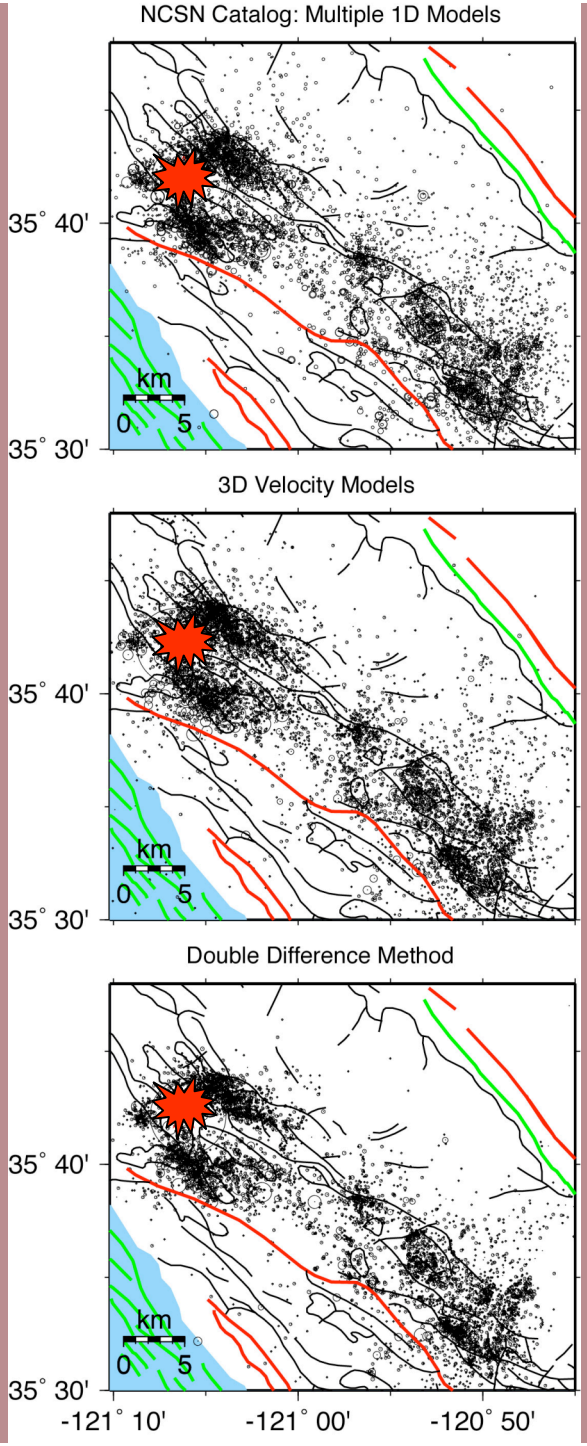
16.0 km



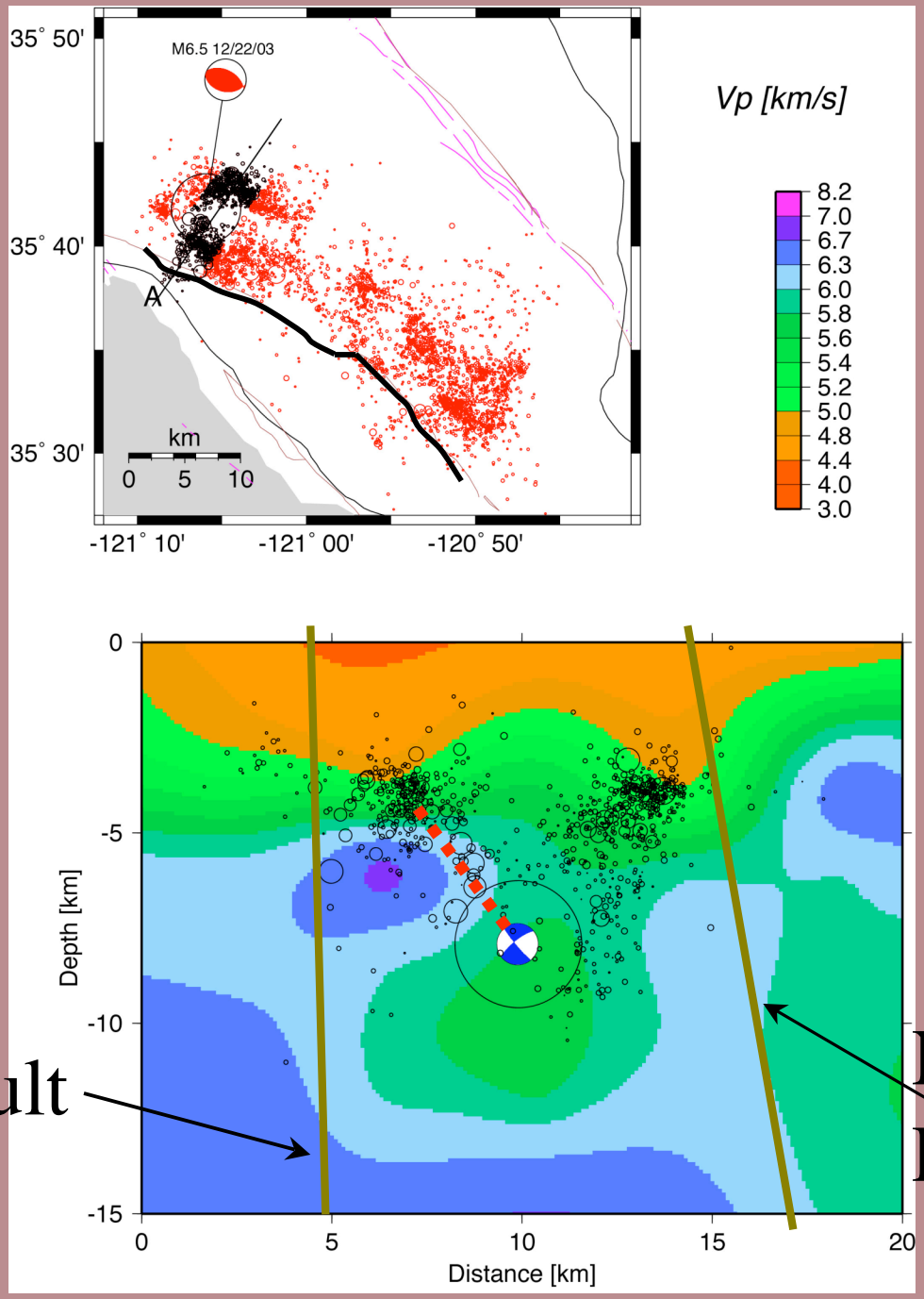


Page et al., (1998)


Depth [km]
2
-2
-4
-6
-8
-10
-12
-14
-16
-18
Vp=4.5 [km/s]
iso-surface
Vp=6.0 [km/s]
iso-surface
Main
shock
Rinconada flt
Nacimiento flt
Oceanic flt
San
Simeon
35° 50′
35° 40′
35° 30′
-121° 10′
-121° 00′
-120° 50′
km
0
5
10


NCSN Catalog: Multiple 1D Models
3D Velocity Models
Double Difference Method
35° 40'
35° 30'
km
0
5
-121° 10'
-121° 00'
-120° 50'

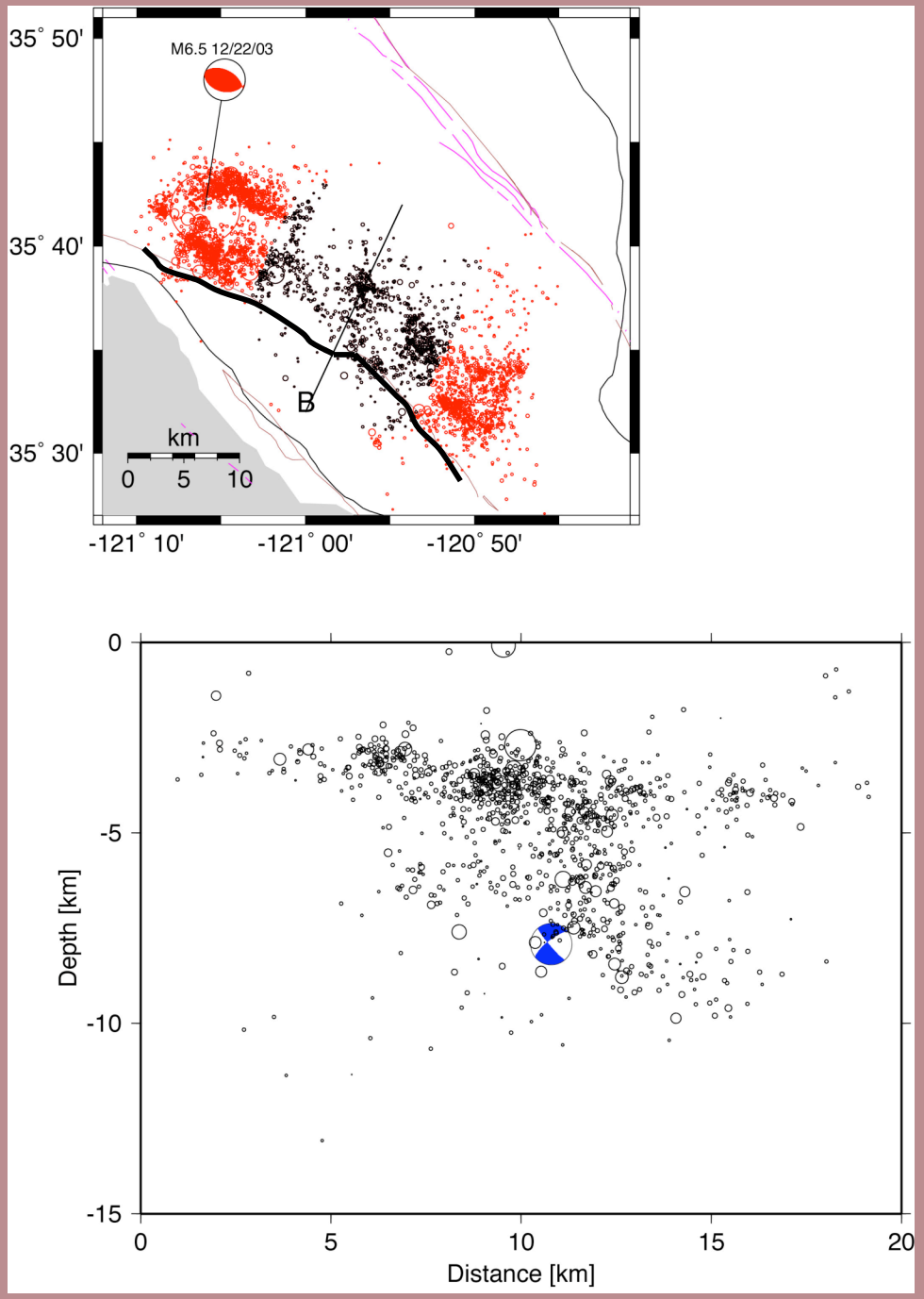
Early
Preliminary
Vp Model
&
Relocations



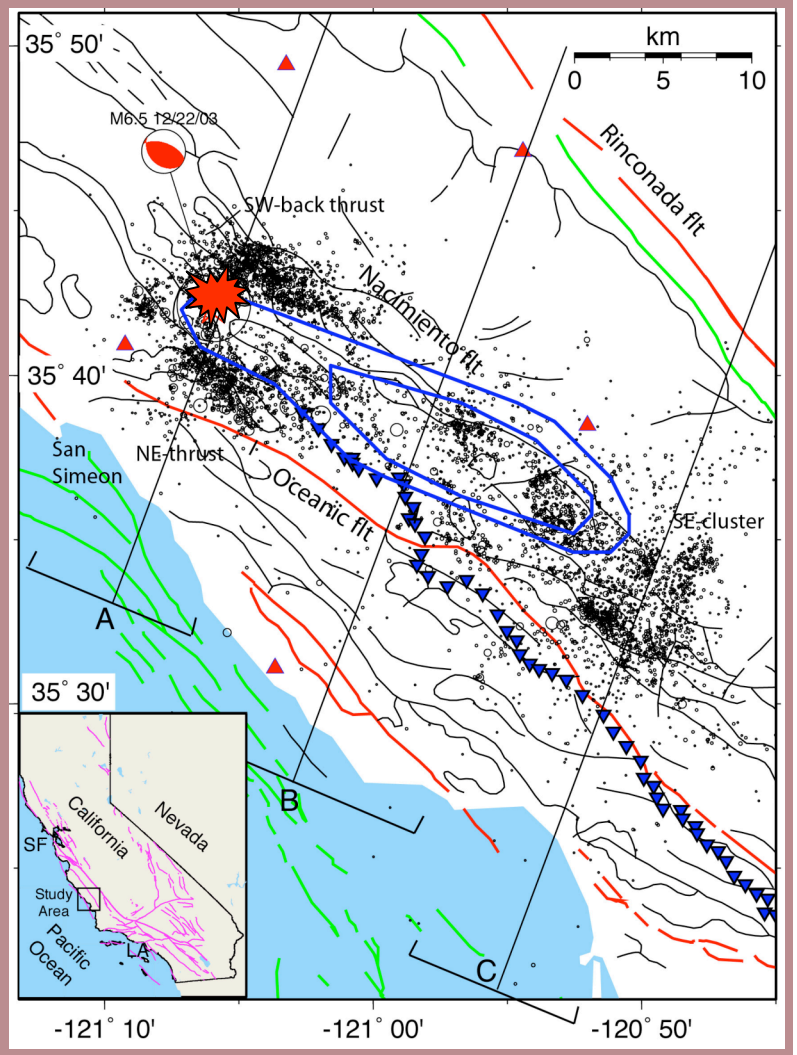
Oceanic Fault

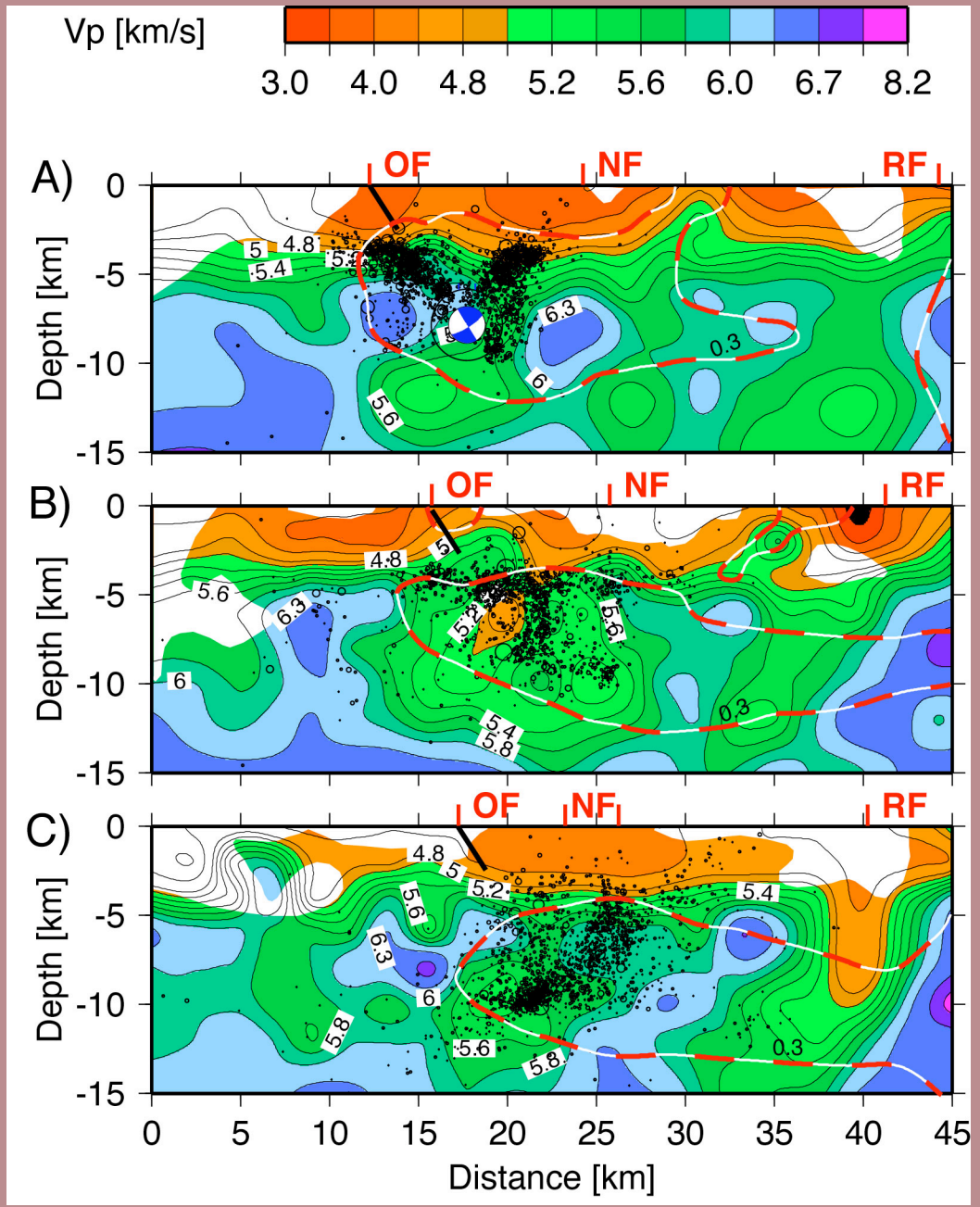
Nacimiento Fault

Early Preliminary Relocations

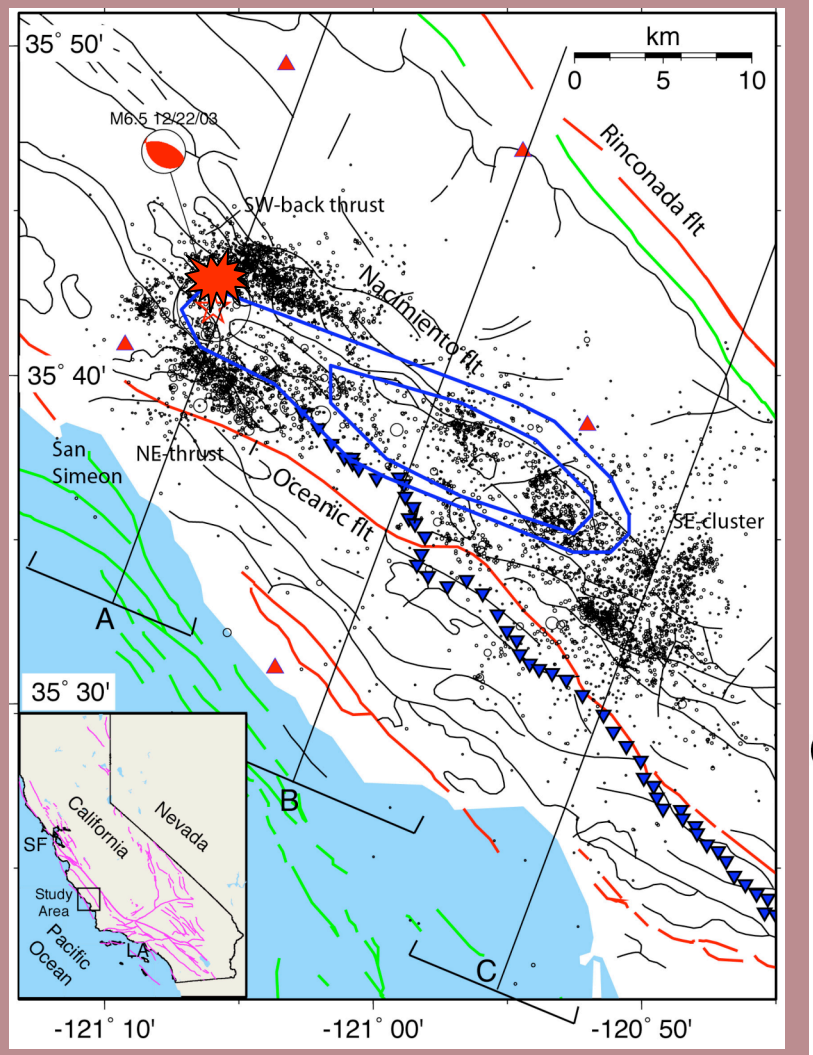


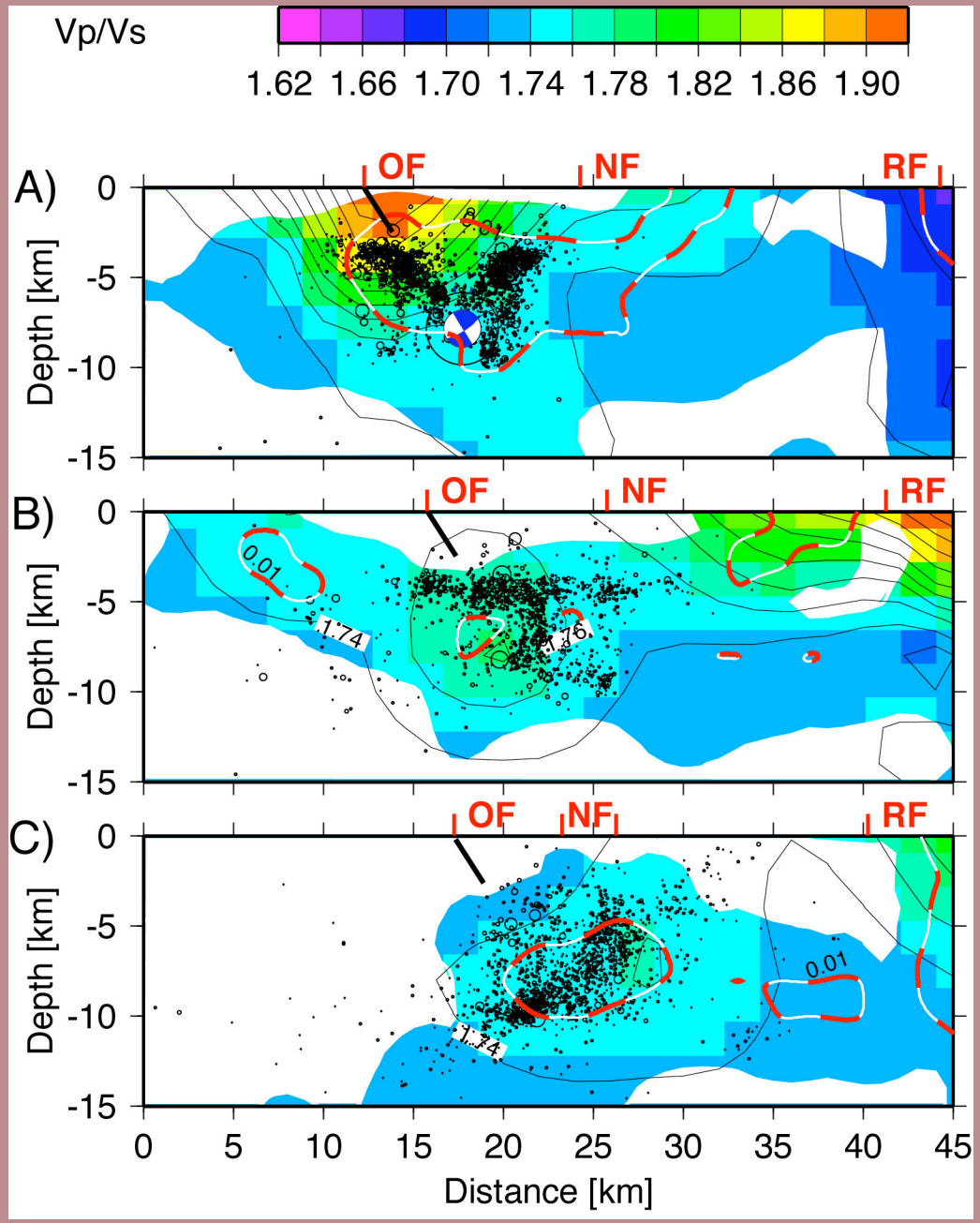
Final Vp Model

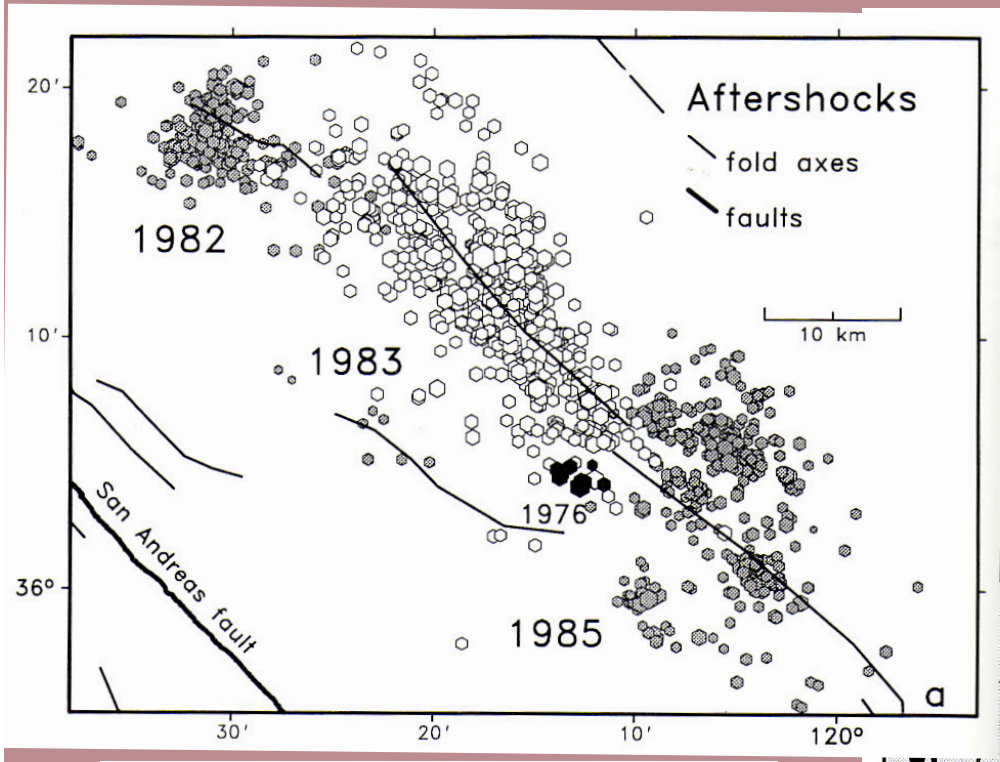


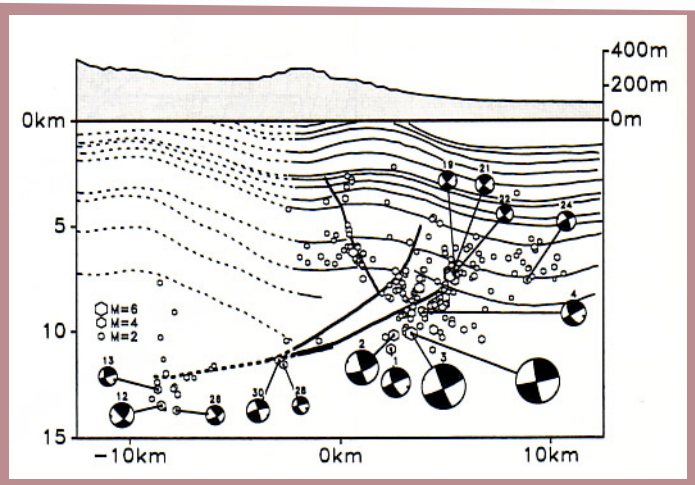


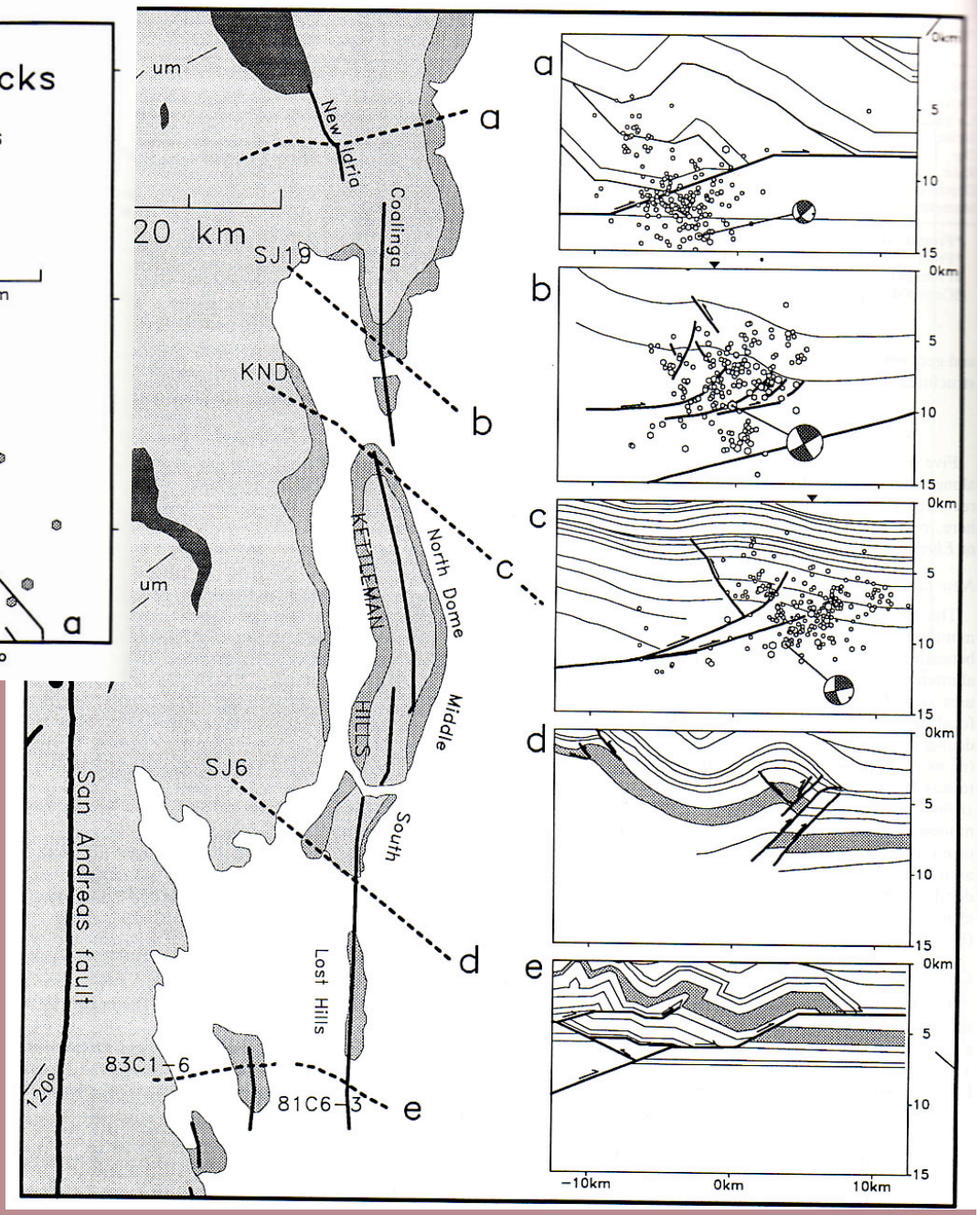
Final Vp/Vs Model





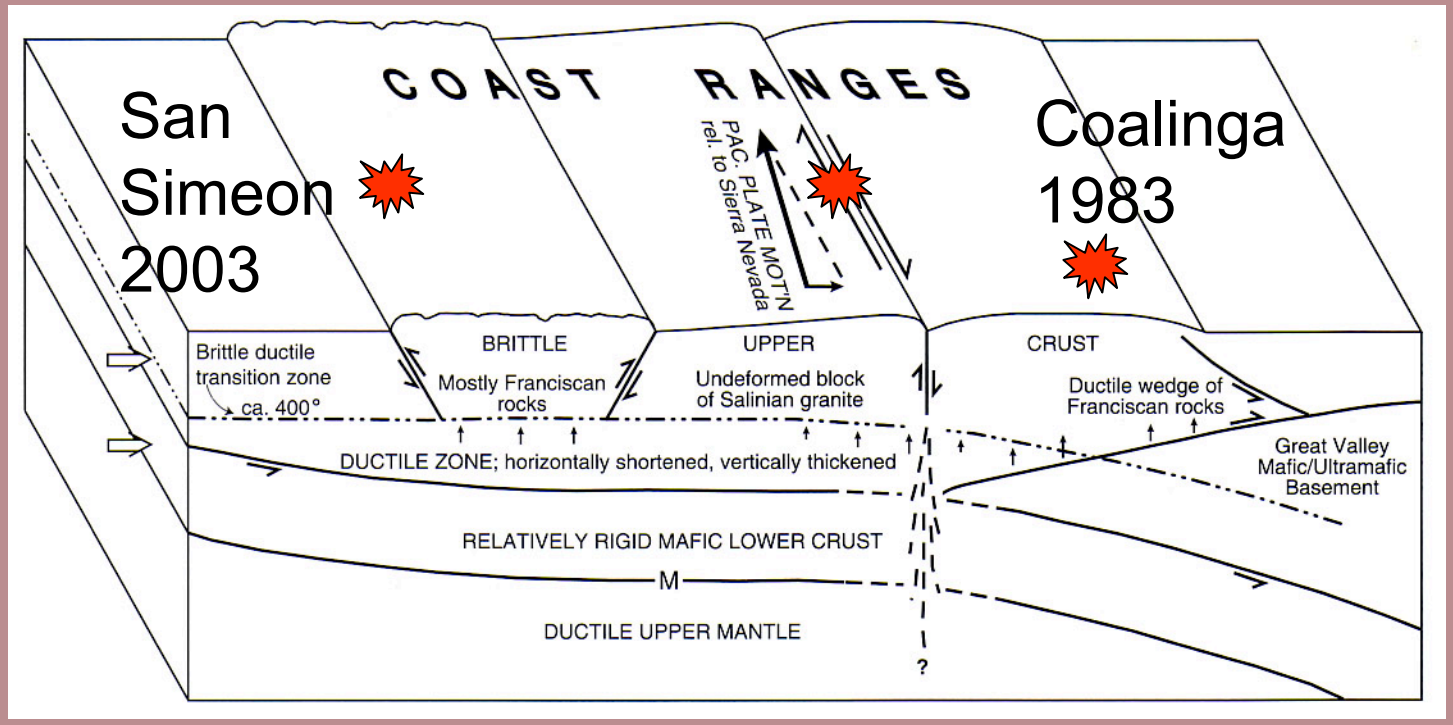






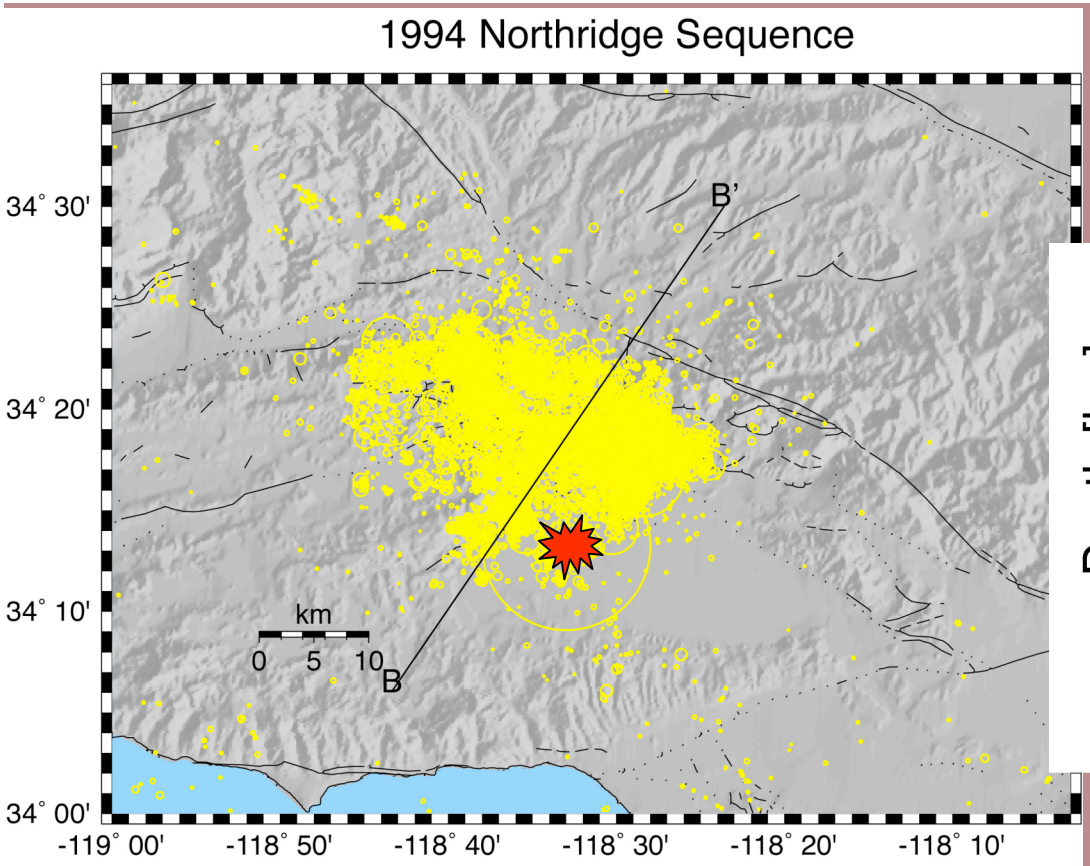
Ekstrom & Stein (1992)
Stein & Ekstrom (1992)

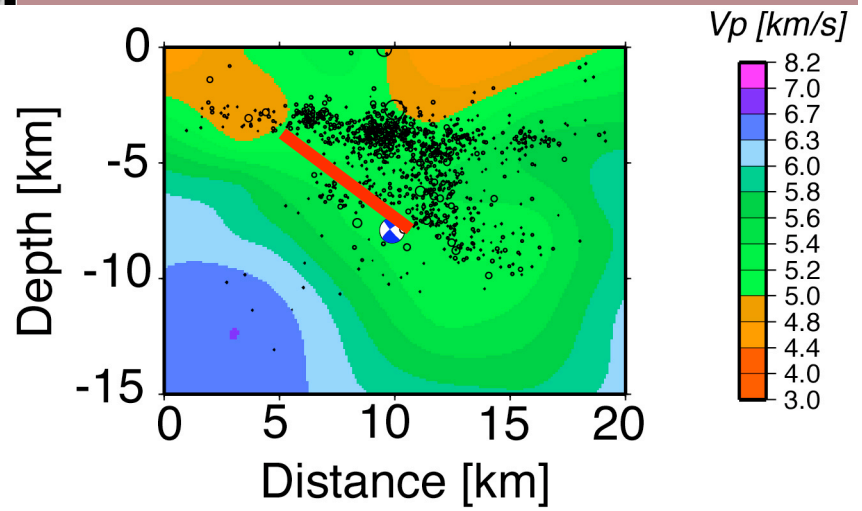
Parkfield
2004

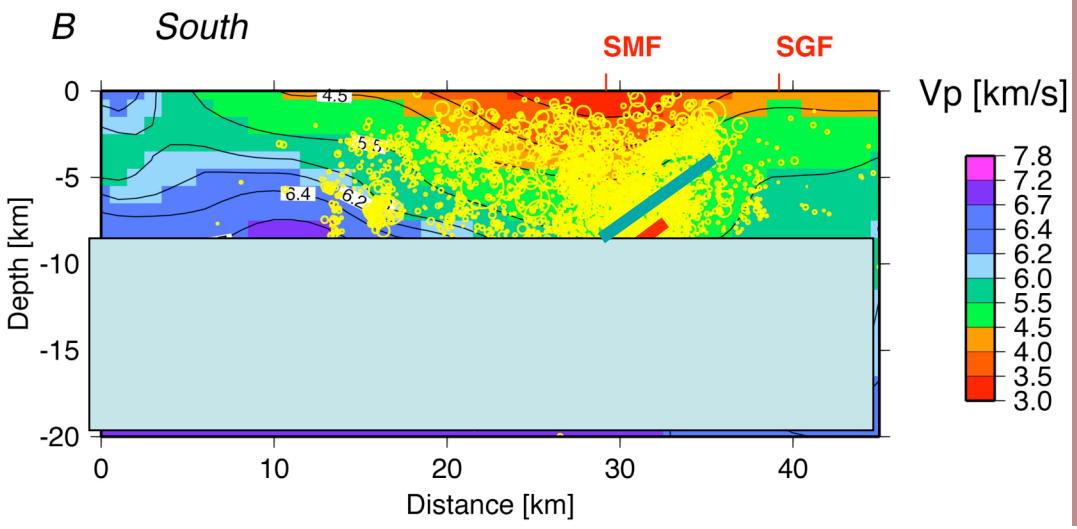


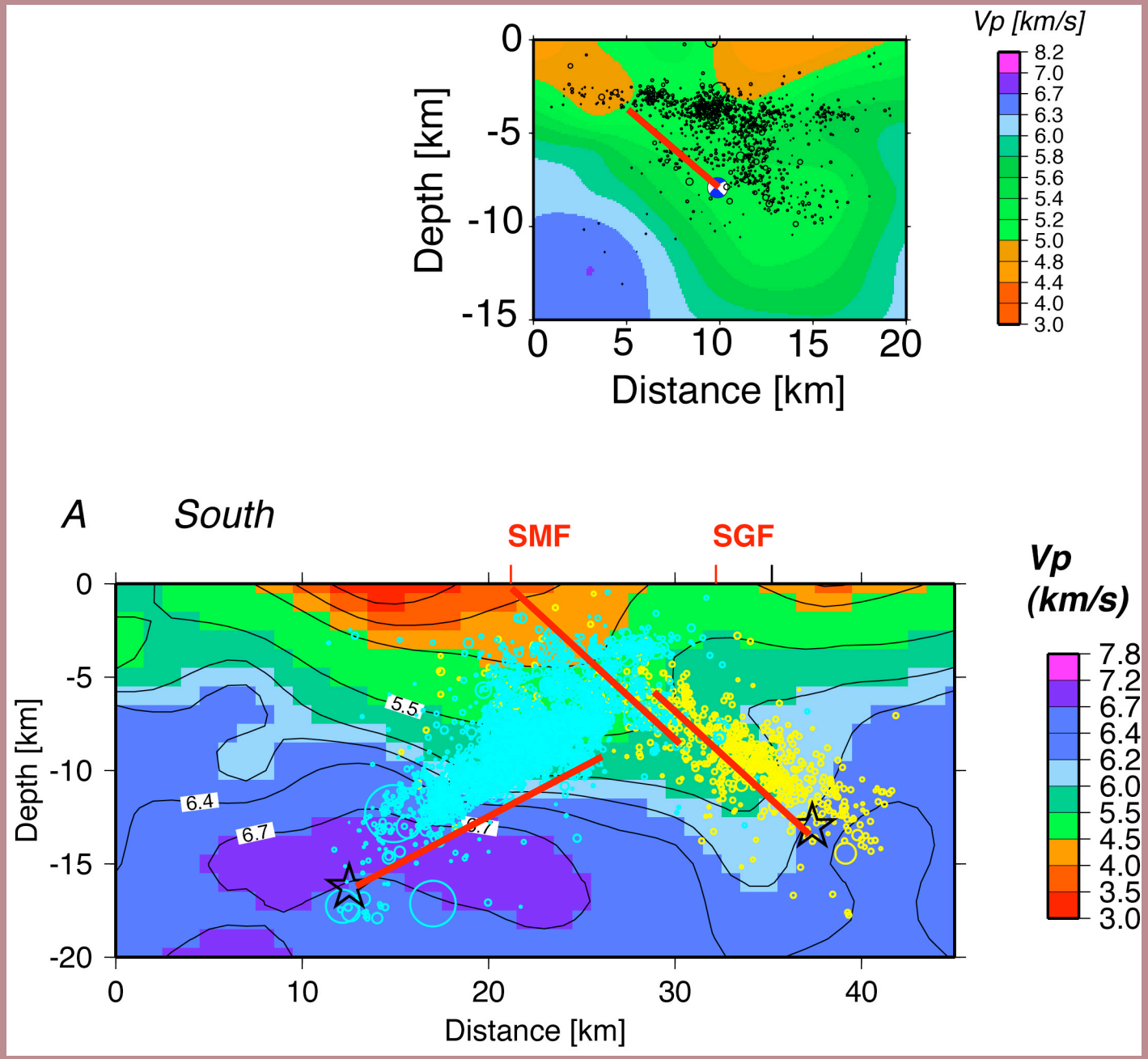
Page et al., (1998)

Major Late Quaternary Faults


1994 Northridge Sequence
34° 30'
34° 20'
34° 10'
34° 00'
-119° 00'
-118° 50'
-118° 40'
-118° 30'
-118° 20'
-118° 10'
B'
B
km
0 5 10


Vp [km/s]
8.2
7.0
6.7
6.3
6.0
5.8
5.6
5.4
5.2
5.0
4.8
4.4
4.0
3.0
Depth [km]
0
-5
-10
-15
0 5 10 15 20
Distance [km]


B
South
SMF
SGF
4.5
5.5
6.4
6.2
Depth [km]
0
-5
-10
-15
-20
0 10 20 30 40
Distance [km]
Vp [km/s]
7.8
7.2
6.7
6.4
6.2
6.0
5.5
4.5
4.0
3.5
3.0


Vp [km/s]
8.2
7.0
6.7
6.3
6.0
5.8
5.6
5.4
5.2
5.0
4.8
4.4
4.0
3.0
Depth [km]
0
-5
-10
-15
0
5
10
15
20
Distance [km]
A
South
SMF
SGF
Vp
(km/s)
7.8
7.2
6.7
6.4
6.2
6.0
5.5
4.5
4.0
3.5
3.0
5.5
6.4
6.7
6.7
Depth [km]
0
-5
-10
-15
-20
0
10
20
30
40
Distance [km]

Conclusions

1) **Aftershocks reflect complex hanging wall deformation**
2) **The sequence occurred in the less rigid Franciscan formation**
3) **Similarities to Northridge and San Fernando but started at much shallower depth**